Earl Iron Bridge
North Road Spanning the Namekagon River
.25 mile north of village of Earl
Vicinity of Earl
Springbrook Township
Washburn County
Wisconsin

HAER No. WI-75

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Rocky Mountain Regional Office
National Park Service
P.O. Box 25287
Denver, Colorado 80225-0287

HISTORIC AMERICAN ENGINEERING RECORD
EARL IRON BRIDGE

I. INTRODUCTION

Location:	Spanning the Namekagon River on North Road (owned by Springbrook Township), .25 mile north of the village of Earl, Washburn County, Wisconsin.
Quad:	Trego, Wisconsin
UTM:	15/595860/5085245
Date of Construction:	1914
Present Owner:	Springbrook Township, Washburn County, Wisconsin.
Present Use:	Vehicular bridge to be replaced by a new vehicular bridge. Projected date of removal is spring 1995. No part of the existing bridge is planned to be retained.
Significance:	The Earl Iron Bridge is a single span, riveted, Pratt overhead truss iron bridge which carries North Road over the Namekagon River in Washburn County, Wisconsin. The bridge was designed by Wisconsin State Highway Commission bridge engineer M.W. Torkelson as a standardized bridge plan and built by Worden-Allen Company of Milwaukee, Wisconsin. The Earl Iron Bridge remains as one of few overhead iron truss bridges extant in Wisconsin which retains a relatively high level of integrity.
Historian:	Barbara M. Kooiman, U.S. West Research, Inc., February 1995.

II. HISTORY

A. HISTORICAL BACKGROUND AND FIRST BRIDGE

The Earl Iron Bridge, where it crosses the Namekagon River, is located in Sections 29 and 30 of Township 40 North, Range 11 West in Springbrook Township, Washburn County, Wisconsin, and is sited approximately 1/4 mile north of the small village of Earl.

Washburn County's early history, from the mid-to-late nineteenth century, is closely related to the large virgin timber stands that once dominated the flat, sandy terrain. Log drives along the rivers of northern Wisconsin, including the Namekagon, were common from the 1860s into the first few years of the twentieth century. River log drives continued in Washburn County until 1902, although intense log drives diminished on the Namekagon by 1880, when the Chicago, St. Paul, Minneapolis and Omaha Railroad was constructed through Washburn County. Lumber was then shipped through various parts of the county, including the tiny village of Earl. [1]

The exact settlement date of the village of Earl is not certain, though the 1896 Washburn County atlas shows no road crossing the Namekagon at the present location of the Earl Iron Bridge, nor the presence of the village of Earl, which prior to 1907, when the post office was established, was known as "Sinclair's Spur." [2]

Earl continued to develop as a small town which served the needs of settlers, who were increasingly turning from a logging-based economy to farming in the early twentieth century. The last log drive on the Namekagon River was remembered to have occurred in 1904. The first store was constructed in 1905 and Earl's first church was constructed in 1907. The first school was constructed prior to 1908. A creamery was organized in the village in March 1916 which operated until about 1940. Farming was the main industry other than the logging throughout the first part of the twentieth century, however by World War II, the larger farming operations put a near end to farming in the area around Earl. Since the 1940s the main industry in the area around Earl has become tourism, with weekend cottages being constructed along the Namekagon River.[3]

The first bridge to be constructed over the Namekagon River north of Earl was a wooden bridge, which according to local history, was constructed between 1903 and 1905. The 1909 Washburn County Atlas confirms that a road passed across the Namekagon at the approximate location of the present Earl Iron Bridge. [3]

B. CONSTRUCTION CHRONOLOGY

The Wisconsin State Highway Commission was first contacted by the town chairman of Earl, J.H. Thompson, in 1912. Though the reason for the decision to construct a new bridge is not documented, it can be speculated that with increased traffic and development in Earl and the surrounding communities, as well as the opportunity for a new bridge presenting itself, the new bridge was constructed in 1914. The survey of the bridge site was conducted by "M.W.T.," presumably M.W. Torkelson, bridge engineer for the Wisconsin State Highway Commission. The 1912 survey form described the road as "good, but sandy" and the existing bridge was a 45-foot combination truss constructed with a substructure of wooden piles. Survey notes indicated that the existing bridge would stay in place during the construction of the new bridge. [5]

The plans for the bridge were drawn up by the Wisconsin State Highway Commission as standard plan Number M296 and the superstructure as A12-N431. The plans were approved on May 22, 1914 and the Wisconsin State Highway Commission let the contract to the Worden Allen Company on June 2, 1914 for the cost of $3,372.00. The bridge was apparently constructed that same summer. [6]

III. BRIDGE HISTORICAL CONTEXT

(All of section III is excerpted from Section 8:1 - 12 of the National Register of Historic Places Nomination form (DOE) for Lynch Bridge, on River Road over the Black River, Neillsville, Clark County, Wisconsin, prepared by Carolyn Roberts, Mead & Hunt, Inc.)

A. DESIGN AND ENGINEERING

There are three essential aspects of a truss. First, a truss is a combination of relatively small members which are "framed or jointed... to act as a beam." Second, each component member is subjected only to tension or compression. (Tensile forces tend to stretch or elongate a member while compressive forces tend to push or compress a member.) Third, the component members of the truss are configured in triangles because "the triangle is the only geometrical figure in which the form is changed only by changing the lengths of the sides." In other words, the triangle remains rigid until the forces applied distort or break the material used in the components.

A truss bridge consists of two trusses, each with a top chord, a bottom chord, and endposts. The space enclosed by these members is called the web. The web members reinforce the truss. The particular arrangement of the web members was the subject of much study in the mid-and late-nineteenth century, and different names were given to trusses with different web configurations. The two most popular types of trusses in Wisconsin were the Pratt and the Warren.

Truss bridges are generally divided into three categories: pony or low trusses, overhead or through trusses, and deck trusses. Both pony and overhead trusses carry the traffic between the trusses and the roadway is at or near the bottom chord of the trusses. A deck truss carries the roadway at or near the top chord; thus, the roadway is on top of the trusses.

B. MATERIALS

The relative merits of cast versus wrought iron for bridge building were still being debated in the late nineteenth century, when the first surge of truss bridge building began in Wisconsin. Because cast iron is brittle, it is subject to sudden and dramatic failure. Thus, it was "an unsatisfactory material for bridges, and quite a number of failures occurred." Shunned for a time in the United States in the 1850s, cast iron bridges made a comeback and then only "gradually, but stubbornly," fell out of favor. As late as 1870, one bridge engineer wrote that "the rigidity of cast-iron is the very quality needed in a compression member." Moreover, as the quality of casting in the United States was excellent, "nothing can be found that will compare with cast-iron for resisting of compression either in reliability or in cost."

Before the issue of cast versus wrought iron had been completely resolved, a new material entered the picture: steel. Steel was not a newly discovered material, of course, but high cost and small output had limited its use mainly to the manufacture of tools. The Bessemer and Siemens-Martin processes reduced the cost and greatly improved the quantity of structural steel available. Steel was used for special purposes and special bridges beginning with Eads bridge in St. Louis in 1874. From the late 1880s to the 1890s structural shapes (beams and columns) were rolled in both wrought iron and steel by the major manufacturers. The quantities and quality of steel remained controversial until the tum of the century, and engineers continued to debate the relative merits of the two metals. Nevertheless steel was the predominant if not exclusive structural material for bridges by the mid-1890s. Although some bridge building companies continued to advertise bridges built of either metal as late as 1900, after 1892 wrought iron structural shapes were no longer being produced.

In the twentieth century, the continued development of steel focused on alloys. Waddell devoted an entire chapter to alloy steels in his 1916 textbook and its 1921 sequel. By 1921, an English engineer indicated that developments since the turn of the century had made both the 'mild' steel of the 1890s and wrought iron old fashioned. Both the engineer and the metallurgist developed an increasingly sophisticated understanding of the variations which resulted from changes in the chemical composition, heat treatment, macrostructure, and microstructure. Because the major advantage of alloy steels lay in very long span bridges and welded connections, the latter feature not becoming common until after World War II, it is assumed that metallurgical developments were not a major concern for bridge engineers designing modest rural bridges such as the ones which predominate the current existing sample in Wisconsin.

On Wisconsin highways, the predominance of metal truss bridges for crossing of all lengths seems to have lasted from about 1890 to 1910. Trusses remained an important bridge type in Wisconsin until the advent of World War II, but after 1910, most short crossings (less than 35 feet) employed girder, beam, or slab spans of steel and/or concrete. The Wisconsin State Highway Commission, established in 1911 to improve the quality of road and bridge construction in the state, was particularly enthusiastic about using concrete for culverts and small bridges.

The two truss designs that came to dominate highway bridge construction by the late nineteenth century were the Warren and the Pratt. The Warren truss was patented by two British engineers in 1840. In this design, the vertical members handle only nominal stress, while the diagonals were usually paired angles, but of small dimension. In Wisconsin, Warren trusses are by far the most common type of highway truss, having been promoted by the State Highway Commission after 1911. Of the approximately 450 Warren trusses in Wisconsin in 1980, over four-fifths were riveted pony trusses built according to State Highway Commission standard plans.

The Pratt truss, patented by Caleb and Thomas Pratt in 1844, features vertical compression members and diagonal tension members. Although originally built as a combination bridge, the Pratt truss was not as efficient in that form as the Howe. As an all-metal bridge, however, the Pratt had the advantage because it used less iron and was easier to erect. The oldest existing truss bridge in Wisconsin, the 1877 White River Bridge in Burlington, is a Pratt.

The development of the Pratt and its variations was influenced by a debate over the merits of pin connections versus riveted connections for main truss members. Proponents of riveted bridges usually cited the advantages of increased structural rigidity and the reduction of damaging vibrations. In pin-connected bridges, vibrations caused the pin to grind on the eye-bar, thus enlarging the pin hole. Advocates of pin-connected bridges, on the other hand, emphasized the theoretically correct distribution of stresses and the small amount of metal required. They also criticized the difficulty of ensuring that a riveted joint was properly fabricated, especially in the field. The pin-connected bridge, they argued, was the reason why Americans surpassed the rest of the world in bridge building.

The issue of pin versus riveted connections was complicated by practical factors, including machinery, tools, and power sources, both in the shop and in the field. The debate also was easily sidetracked by tangential issues, as, for example, when some commentators denied that the pin *per se* was the most important feature of "characteristically American" bridgework. In addition, both connection types came to incorporate features that were not an intrinsic part of the design. Many early riveted spans, for example, used the lattice girder (or multiple triangulation) design, which was clearly excessive in material, while many pin-connected bridges were dangerously light, particularly in their details. Thus, a fair comparison between the two systems was not

always made.

According to J.A.L. Waddell, the controversy raged in engineering circles for a dozen years around the turn of the century. No dramatic resolution of the issue occurred, but "time and steady development of the real science of bridge designing" gradually changed minds. Significant changes in riveting technology also altered the terms of the debate. A compromise of sorts was finally reached, resulting in the adoption of the best features of each design. Riveted bridges were designed with less duplication of members and pin-connected bridges, suitably detailed, were still accepted for long-span highway bridges.

In Wisconsin, State Highway Commission officials favored riveted construction from an early date. Consequently, the distinction between pin connections and riveted connections established an important subcategory boundary, separating the era of state-planned bridges from the preceding period in which bridge companies were largely responsible for bridge design. As early as 1908, state engineers advocated the use of riveted pony trusses for short-span bridges. When the State Highway Commission was formally established in 1911, the riveted Warren became the state's standard pony design. In that year, the State Highway Commission also drafted a standard plan for riveted, overhead, Pratt trusses, and by 1914, the agency had adopted riveted construction for all overhead Pratt variations. As State Highway Commission engineer A.R. Hirst wrote in 1913, "Very seldom do we use a pin-connected truss..."

In the mid-1930s the State Highway Commission seems to have developed a preference for overhead Warren trusses for long-span bridges, although some overhead Pratts continued to be built. Riveting remained dominant in bridge building until well after World War II. As late as 1931, the construction specification of the American Association of State Highway Officials (AASHO) stated, "Welding of steel shall not be done except to remedy minor defects and then only with the approval of the engineer." As with other innovations, the full potential of welded bridges had yet to be seen. Shortly thereafter, riveting rapidly disappeared, replaced by welding the high strength bolts.

IV. THE BRIDGE

A. DESCRIPTION

The Earl Iron Bridge is a single span (91.2') riveted, Pratt overhead truss, iron bridge, carrying North Road over the Namekagon River in rural Springbrook Township, Washburn County, Wisconsin. It is located about .25 miles north of the unincorporated village of Earl. The Namekagon River is a tributary of the St. Croix River and the entire Namekagon River is part of the St. Croix National Scenic Riverway.

The Pratt truss bridge is described as a design of equilateral triangles, which utilize diagonal members in tension and vertical members in compression. Though a variety of iron trusses were designed in the late nineteenth and early twentieth centuries in this country, the Pratt was originally patented by Thomas and Caleb Pratt in 1844. The majority of Pratt overhead truss iron bridges built in Wisconsin from 1911 to 1925 were standard designs from the Wisconsin State Highway Commission plans. [7]

The Earl Iron Bridge standard plan design was developed by the Wisconsin State Highway Commission Bridge Engineer M.W. Torkelson, who specifically revised the plans for the Earl bridge in 1914 to suit the location. [8]

The truss was constructed with a 90 foot span and a 16 foot roadway with concrete floor. The height from the floor to the overhead bracing is 18 feet. The intermediate bracing is attached at the truss sides to leave an overhead clearance of approximately 13 feet. The road approach to the bridge from the south comes down a hill which levels out briefly before reaching the bridge. The approach from the north is level for a few hundred feet before reaching the bridge.

The truss is constructed with pin truss members, and riveted connections. It is supported on the abutments by fixed bolted 1 1/4" and 1/2" angles on the fixed end and end bearings on the expansion end. The roller boxes contain five 3" rollers, 1'6" long each. The abutments, which are detailed in Plan #M296, indicates that the abutments are constructed of Class B concrete, reinforced with 48 steel bars, 1/2" x 17', and 44 wood piles, 16' long, and 10 - 12" butts. [9]

The end posts and top chord are built of the same construction, and consist of one plate, welded to two angles, reinforced by lattice on the underside. All of the compression beams are two laced angles, and the tension members are double 3 x 3 x 5/16" angles. The intermediate bracing is constructed of two angles, laced. For details of all beam size and construction methods, see Wisconsin State Highway Commission standard plan A-12.

B. OWNERSHIP and FUTURE

The Earl Iron Bridge is currently owned by Springbrook Township, Washburn County, Wisconsin. The bridge is able to carry only one lane of traffic, and is unable to serve community needs to carry heavy trucks and school buses. The township has requested that a new bridge be constructed at the same location and plans are progressing to construct the new bridge in the summer of 1995, necessitating the demolition and/or removal of the Earl Iron Bridge from its current location.

V. BIOGRAPHICAL MATERIAL

A. WISCONSIN STATE HIGHWAY COMMISSION

(Excerpted from Section 8:1 - 12 of the National Register of Historic Places Nomination form for Lynch Bridge, River Road over the Black River, Neillsville, Clark County, Wisconsin. Prepared by Carolyn Roberts, Mead & Hunt, Inc.)

The Wisconsin Highway Division was first established by state legislature in 1907 under the Wisconsin Geological and Natural History Survey, providing local governments with advise on road and bridge projects. By 1911 the legislature elected to provide state appropriations to local transportation projects and at the same time transformed the Highway Division of the Geological Survey in an autonomous State Highway Commission which oversaw the expenditure of state funds for the development of a state highway network.

Between 1911 and 1915 the State Highway Commission designed over 1,500 bridges of all types, utilizing as much concrete as feasible. Nearly all bridges designed by the Commission were built with concrete floors. Despite the favoritism toward concrete, the iron truss bridges remained popular and cost effective until well after World War II.

B. WORDEN-ALLEN COMPANY

(This entire section is excerpted from Wisconsin-Department of Transportation computer files on Wisconsin bridge companies)

The Worden-Allen Company was founded shortly after the turn of the century while Beverly L. Worden was still construction engineer for Wisconsin Bridge and Iron. The firm may have been more Worden than Allen as Clarence J. Allen appears to have been associated with the company, as secretary-treasurer, from the founding only until 1907. Although the name remained Worden-Allen, Beverly Worden achieved more prominence by far.

Beverly Worden, born in Chicago in 1871, worked as an apprentice engineer at the Wisconsin Bridge and Iron Company before he sought and received a degree in civil engineering from the University of Wisconsin in 1893. After getting his degree, he listed himself first as a civil engineer, then, in 1895, as a bridge engineer, and then, from 1896 to 1902 as a contracting or construction engineer. The latter term may refer to a superintendent position with the Wisconsin Bridge and Iron Company.

The Worden-Allen Company was formally incorporated December 13, 1902. It soon became one of the largest twentieth-century bridge companies in the midwest with offices in Chicago,

Milwaukee and Houghton, Michigan. By 1911, the firm had a structural steel capacity of 12,000 to 15,000 tons per year and grossed over one million annually. In 1915, it advertised itself as "General Contractors for Fire Proof Construction" and claimed to manufacture "All Kinds of Structural Steel Work" with offices in Buffalo, New York City, Chicago, and Houghton, Michigan. The plant, and presumably the home office, were still in Milwaukee. Only Chicago and Duluth, Minnesota, were listed as other offices, however, and it called itself "Consulting and Contracting Engineers" and distributors of Massillon Bar Joists. It also listed a number of structural shapes, as well as shafting and sheets, on hand for "Immediate Shipment."

Worden-Allen built a number of Warren pony trusses based on the standardized plans of the State Highway Commission. The company also built the first known riveted Pratt overhead truss bridge in Wisconsin in 1909. This was a design which the State Highway Commission advocated in its 1912 set of standardized plans, and is apparently the plan which was used for the Earl Iron Bridge. Also, in 1909, Worden organized a subsidiary bridge company, the Lackawanna Bridge Company with offices in Milwaukee, Buffalo and New York. In 1921, Lackawanna included in its advertisements: "General Contractors for Fireproof Construction." (It is of note that the large metal members of the Earl Iron Bridge are imprinted with the name"Lackawanna.") In the years before World War I, Worden apparently commuted between Milwaukee and the east. The Worden-Allen Company continued to build bridges in Wisconsin as late as 1933. The company dissolved December 30, 1977.

VI. FOOTNOTES

1. Ward E. Winton and Kay Brown Winton, eds. Historical Collections of Washburn County and the Surrounding Indianhead Country , 3 vols. (Shell Lake, WI: White Birch Publishing, 1983), 3: 1.

2. Ward E. Winton and Kay Brown Winton, eds. Historical Collections of Washburn County and the Surrounding Indianhead Country, 3 vols. (Shell Lake, WI: White Birch Publishing, 1980), 2: 462; Busch & Harmon, Map of Washburn County, Wisconsin, May 1896. (Spooner, WI: Geo. W. Harmon, 1896).

3. Ward E. Winton and Kay Brown Winton, eds. Historical Collections of Washburn County and the Surrounding Indianhead Country, 3 vols. (Shell Lake, WI: White Birch Publishing, 1980), 2: 461.

4. Ward E. Winton and Kay Brown Winton, eds. Historical Collections of Washburn County and the Surrounding Indianhead Country, 3 vols. (Shell Lake, WI: White Birch Publishing, 1980), 3: 235; Ibid, 2: 460; Busch & Harmon, Map of Washburn County, Wisconsin, May 1896, Revised 1909. (Spooner, WI: Geo. W. Harmon, 1909).

5. Wisconsin State Highway Commission. Plans, Inspection Reports, Data Files, 1911 - 1941, filed in Bridge Section, Wisconsin State Department of Transportation, Madison, WI, Microfilm Reel F100, P-65-36, 1914.

6. Ibid., Microfilm Reel F100, P-65-36: Report of Survey.

7. Barbara Wyatt, ed. Cultural Resource Management in Wisconsin, 3 vols. (Madison, WI: Historic Preservation Division, State Historical Society of Wisconsin, 1986). 2: Transportation: 12 -12 to 12- 15]

8. Wisconsin State Highway Commission. Plans, Inspection Reports, Data Files, 1911 - 1941, filed in Bridge Section, Wisconsin State Department of Transportation, Madison, WI, Reel M-1.

9. Ibid.

VII. BIBLIOGRAPHY

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Winton, Ward E. and Kay Brown Winton, editors. Historical Collections of Washburn County and the Surrounding Indian Head Country. Volume III. Shell Lake, WI: White Birch Publishing, 1980.

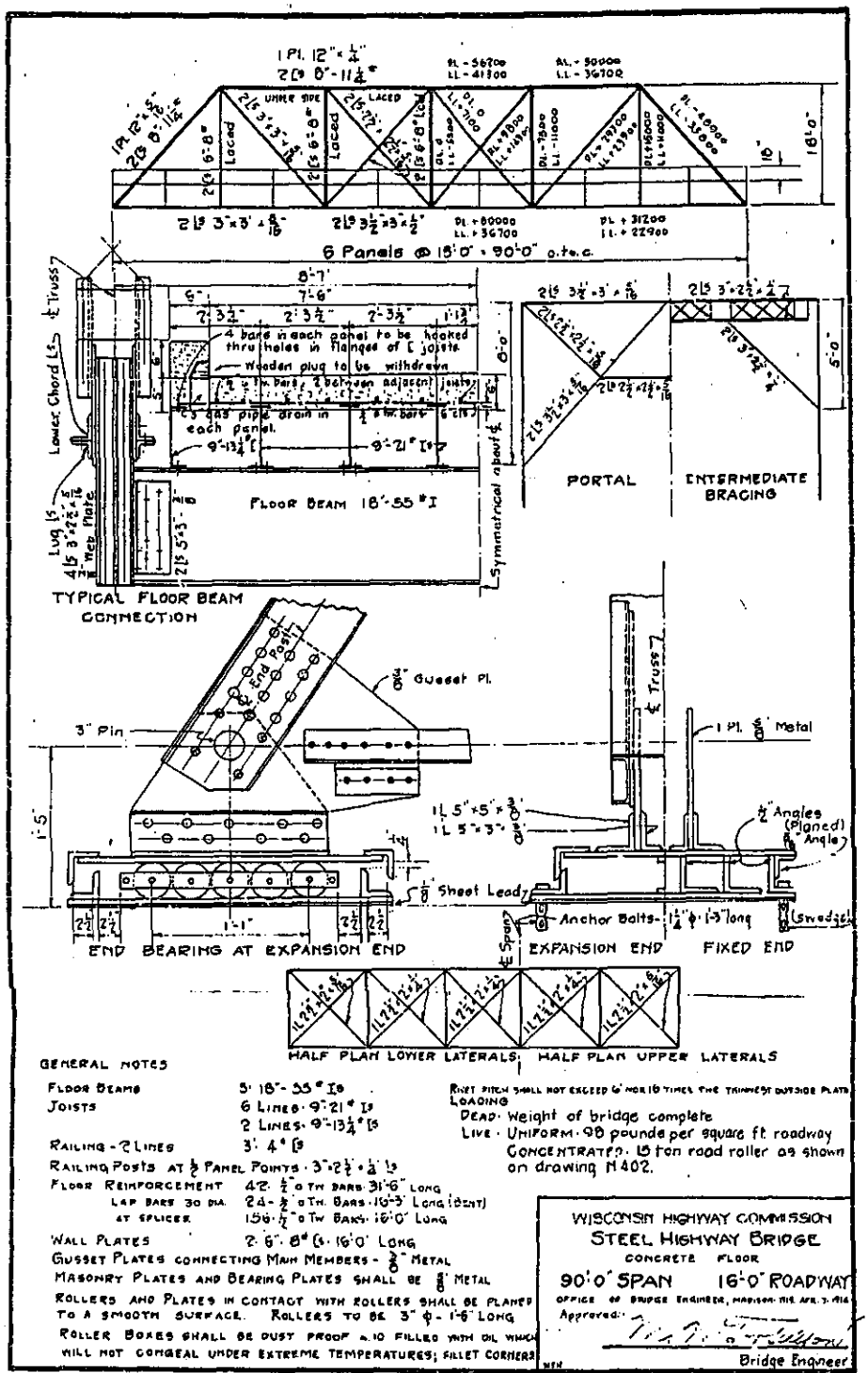
Wisconsin Department of Transportation. Computer files kept by Mr. Robert Newbery, Environmental Section, WisDOT, Madison, Wisconsin.

Wisconsin State Highway Commission. Plans, Inspection Reports, and Data Files, 1911 - 1941, filed in Bridge Section, Wisconsin Department of Transportation, Madison, Wisconsin. Includes microfilm reel F100.

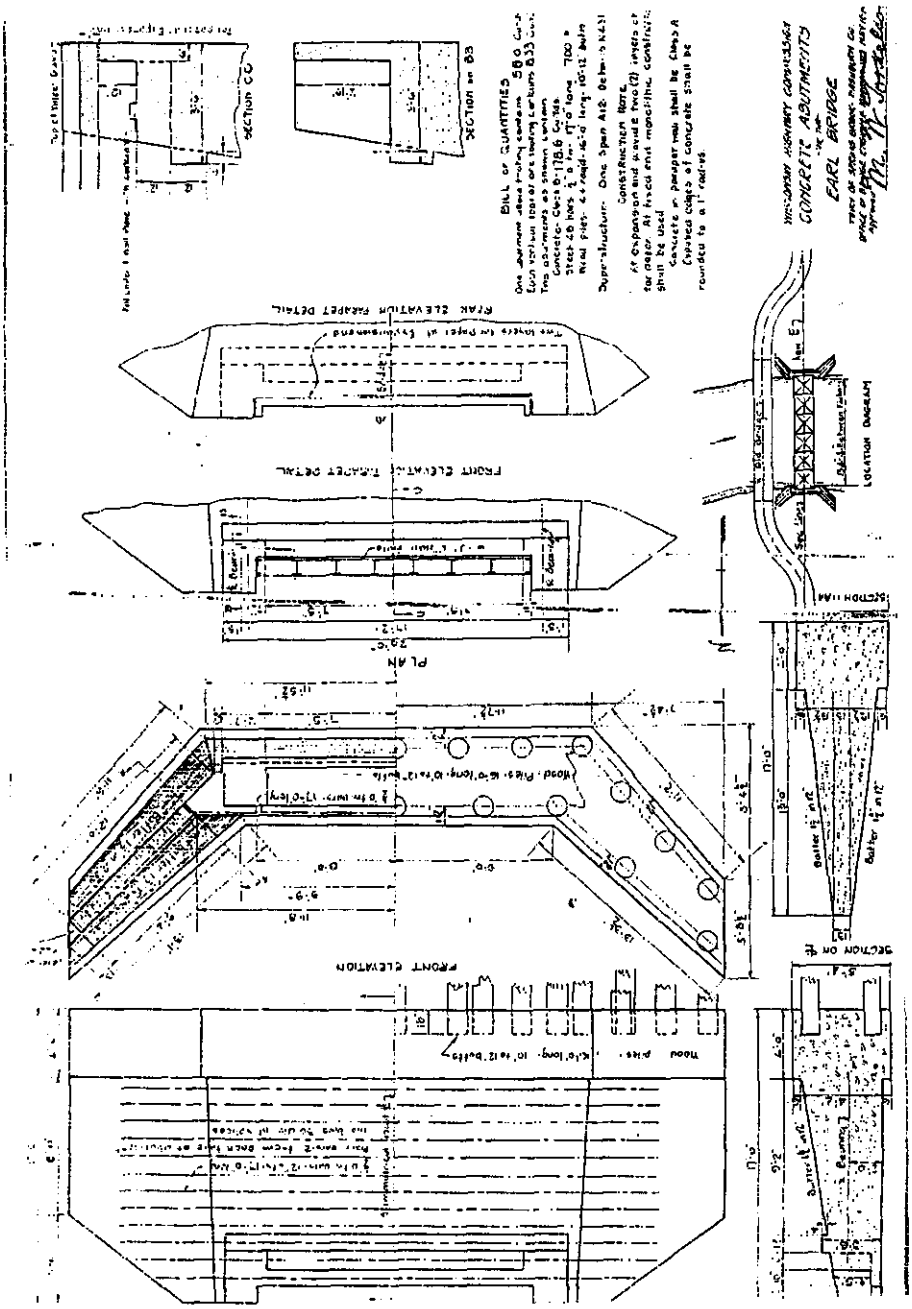
Wyatt, Barbara. Cultural Resource Management in Wisconsin, Vol. II. Madison, WI: Historic Preservation Division, State Historical Society of Wisconsin. 1986.

Standard Plan A12 from Wisconsin Highway Commission files Dated April 7, 1914

Located on microfilm, Wisconsin Department of Transportation, Madison, Wisconsin.



2 Trusses-40% Det.	22150#	Joists 90'@ 152.5#	13730#		
Bracing-40% Det	1800	Railing 90'@ 16#	1440	TOTAL STEEL	54600#
Portals-30% Det	1930	Reinforcing	3580		
Laterals	1800	Rail Posts 5'	360	CONCRETE-1:2:4 Mix	
Floor Beams-5	4850	Shoes	2700	92' @ 0.29 = 26.7 Cu Yds	
		Wall Plates	260		



Concrete Abutments for
Earl Bridge, Washburn Co.
Drawn to accommodate
Plan A12

Dated May 16, 1914
Plan M296

Located on microfilm,
Wisconsin Department
of Transportation,
Madison, Wisconsin.

Map of Washburn County, Wisconsin
Showing location of Earl Iron Bridge

Earl Iron Bridge
HAER No. WI-75
Page 14